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Postoperative Management And Core Stabilization Interventions For A Semi-Pro Football Athlete Following Lumbar Discectomy: A Case Report

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The Patient signed an informed consent allowing the use of medical information for this report and received information on the institution's policies regarding the Health Insurance Portability Act.

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Abstract: Although there is evidence to support a high success rate to return to work in the general population and to sports play in athletes following discectomy, less is known regarding the interventions that played a role in their return. The following case describes the interventions and management of a recreational football player following discectomy.

Case description: The patient was a self-described highly active 24-year-old male post discectomy. The patient had pain, poor body mechanics, gait abnormalities, range of motion deficits, and strength deficits of his low back and lower extremities. Physical therapy interventions included soft tissue mobilization, stretching, exercise, and education.

Outcome: This patient showed decreased pain and improvements in muscle strength, range of motion, gait, and body mechanics.

Discussion: Disability and functional limitations following discectomy improved with core exercises, soft tissue mobilization, and education. Research is warranted to investigate the long term implications following this type of surgery.

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Background and Purpose:

Low back pain (LBP) is commonly reported among adults with estimates of 8 in 10 individuals experiencing LBP in their lifetime. Despite the prevalence of LBP, many cases are idiopathic and do not have a clear pathological cause. In the case of LBP with leg pain or sciatica, it may be in result of a lumbar disc herniation (LDH) exerting pressure on the nerve root. When this occurs, several non-surgical treatment options have shown to relieve both leg and back pain following stretching, lumbar extension exercises, and lumbar traction.[1,2,3] In many other cases, however, surgery is required due to the severity of herniation.[4, 5, 6] Fortunately, following discectomy for LDH, the success rate to return to work and sports is 92% and 82% in the general population, respectively.[7, 8, 9]

For professional or recreational athletes, the expectations for recovery and satisfaction may differ considerably compared to the general population due to demands, conditions and physical expectations to return to play. Professional athletes have been successful to return to sport following lumbar discectomy with an average of 89% after single-level lumbar discectomy.[10] The length of time athletes required to return to football varied as early as 3 months to a year.[9]

Core stability training has been a key component in many physical therapy interventions when providing care for patients who are limited due to LBP. Anoop et al.[11] concluded that core stability training leads to significant improvement in the lower trunk endurance performance in the recreationally active adult (18-27 years). The transversus abdominis (TA) and lumbar multifidis (LM) muscles have also been hypothesized to play a key role in lumbar spine stability and account for two thirds of the stability at the L4-5 segment.[12] Moreover, the importance of abdominal bracing and motor control to elicit proper firing of these muscles and core during

stabilization and functional exercises cannot be over emphasized for patient's following lumbar surgery.

Although there is an abundance of evidence regarding the improvement in back pain, range of motion (ROM) and function with core stabilization and trunk exercises,[13,14,15,16] as well as positive outcomes to return to professional sports following lumbar discectomy,[9,10] less is known regarding the specific interventions following lumbar discectomy in recreational athletes. Due to the evidence supporting stabilization exercise programs, as well as the evidence to improve function, return to sports, and to decrease pain severity, interventions emphasizing lumbar stabilization would appear to be an appropriate therapeutic option for individuals following lumbar discectomy. The purpose of this case report is to describe the physical therapy management, including core stabilization exercises for a semi-pro football athlete following lumbar discectomy.

Case Description:

The patient was a self-described highly active 24-year-old male (height, 175.3 cm; body mass, 108.9 kg; body mass index, 35.4 kg/m^2) prior to lumbar surgery. The patient reported that LBP originally started three months prior to the physical therapy initial evaluation from squatting exercises at the gym. He explained that although he had LBP, he continued to play in a semi-pro football league for the remaining six weeks of the season. One month after, he underwent surgery for LDH after his symptoms progressed to numbness and pain down his legs. Following the L4-5 discectomy, the patient was referred to physical therapy for postoperative aftercare including lumbar stabilization exercises, home exercise program, patient education, and core / abdominal exercise. The patient described his pain to be best sitting or lying supine mid-day and

worst in the morning during bending, twisting, or sitting for long periods of time as a tattoo artist. Hydrocodone had been used sparingly for pain in order to function during work, but he denied use of more than a handful of times. The patient had a fractured thumb (2002) and a minor lateral collateral sprain (2008), but no previous history of low back pain. He denied any significant family history of heart disease, hypertension, or diabetes that may otherwise complicate his recovery. The patient denied any history of smoking. On occasion, pain disturbed sleep when rolling in bed, however, the pain dissipated after finding a comfortable position.

The patient's main goals were to be pain free in order to function normally during work, improve strength and endurance, and to regain mobility, strength, and cardiovascular and muscular endurance to play football. His goal was to try-out for the 2016 semi-pro football season six weeks after the initial physical therapy evaluation.

Systems Review:

The patient's cardiopulmonary system review revealed a resting pulse rate of 64 bpm, blood pressure of 128/81 mm Hg, and respiratory rate of 22 breaths per minute. Sensation, crude and fine touch, as well as gross coordinated movements were intact. However, the patient did demonstrate a right lateral lean and antalgic gait pattern. The patient appeared to be endomorphic in body structure, alert, cognitively oriented, communicated well, and preferred pictures and demonstrations as his learning styles. Upon review of his integumentary system, no abnormalities were present besides the incision scar (5 cm in length) with palpable hypertrophy superficial to his L4-5 vertebrae. No signs of infection, edema, or ecchymosis were observed. Following review of the patient's musculoskeletal system, the patient demonstrated gross

strength and ROM impairments of the trunk and lower extremity. His posture displayed rounded shoulders bilaterally, a forward head posture, and a decreased lordotic curve.

Clinical Impression I:

The patient's primary problem was LBP and impaired functional mobility. It appeared that LBP was causing hypomobilty of his trunk which was affecting his gait pattern and contributing to the neuromuscular and musculoskeletal systems. Therefore, his examination primarily consisted of assessing his pain, trunk and lower extremity (LE) range of motion (ROM) including flexibility, strength, and functional mobility. Functional mobility was primarily assessed during demonstration of a squat.

Because the patient was medically stable, and his symptoms of pain were consistent with patients following surgery, there were no ramifications to address possible differential diagnoses. This patient was a good candidate for a case report because although it has been shown that athletes are able to return to sport following lumbar discectomy, more research is needed to describe the postoperative rehabilitation interventions that were utilized.

Examination:

Palpation

There is preliminary evidence supporting the reliability and validity of the multifidis lift test (MLT) to assess lumbar multifidus function at the L4-5 spinal level[17]. The lumbar multifidis muscles revealed poor contraction bilaterally as well as increased firmness and multiple trigger points throughout the thoracic musculature. There was increased sensitivity with palpation to the

scar but decreased sensation on the periwound. Joint mobilization and integrity of cervical, thoracic, and lumbar vertebrae were rated as grade 2, or slightly hypomobile.[18]

ROM and Flexibility

Trunk ROM was determined by percent limitation described using reliable and valid measurements by Starkey and Brown.[19] (Table 1). Passive straight leg raise test (SLR) test was found to be negative for sciatica bilaterally, but positive for low back and hamstring tightness. The SLR is commonly used to assess the normality of the roots of the sciatic nerve as well as the tightness of the hamstring muscles.[20] The straight leg raise (SLR) test has been shown to favor test-retest reliability in patients with LBP,[21] but has not been shown as a reliable test for LDH if compared with MRI results.[7] The patient was limited moderately during the test due to hamstring tightness.

The Thomas test was performed to assess quadriceps and hip flexor flexibility, which has shown to be a valid and reliable test.[22] The patient demonstrated a positive Thomas test with external hip rotation. This observation was confirmed during a positive Ober's Test. The Ober's test is used to assess for tightness of the ITB and tensor fascia lata along the lateral aspect of the hip and thigh.[19] Although there is limited support for the validity of this test, Reese et al[23] has shown to support reliability.

Strength

Standard manual muscle techniques (MMT) described by Clarkson and Gilewich[24] were used to assess the trunk and LE during manual muscle testing. These techniques has been shown to be reliable and valid.[24] The primary impairments were abdominal, low back, and hip

weakness. Although abdominal weakness was noted as a 4/5, it was unclear during the examination whether it was solely the result of weakness or due to low back pain during the test movement (Table 1).

Functional assessment

A functional assessment of the patient's body mechanics was observed using joint-by-joint analysis of the squat mentioned from McKean et al.[25] The patient displayed poor body mechanics when performing a squat including excessive hyperextension of the lumbar spine at initiation of the squat, poor hip flexion, excessive lumbar flexion at the bottom of the squat, and poor motor control of the hip, knee, and ankle joints. This resulted in excessive ankle dorsiflexion and knee flexion with poor hip flexion during the squat, ultimately resulting with the patient heavily weighted anteriorly on his toes with his calcaneous slightly off the floor. At the time of examination, the patient was unable to perform more than 25% of his reported normal range due to back pain and muscle tightness following surgery (Table 1).

Lastly, the Oswestry Back Index is a self-administered questionnaire designed to assess disability due to low-back pain. The questionnaire offers a valid and reliable way to measure and accurately assess changes in the patients' disability.[26]

Clinical Impression II:

Based on the examination findings, the data support the initial clinical impression that LBP led to the primary cause of the patient's impairments and functional limitations. It was clear that pain affected mobility of the spine. The stiffness and pain of the lumbar region led to the subsequent postural abnormalities during gait, poor trunk and LE flexibility and strength,

ROM, and endurance. The patient's poor understanding of lumbar precautions due to his poor body mechanics may have also contributed to his musculoskeletal impairments, resorting to moving en bloc and becoming over cautious and in result self-limiting his ROM . The patient's demonstration of poor technique highlights a key contribution to the original mechanism of injury. The risk for reinjury due to poor body mechanics has been highlighted as a priority of treatment and suggests this patient is a good candidate for physical therapy.

Due to the following orthopedic symptoms in result of the patient's surgery and no prior history of gait abnormalities, the patient's physical therapy diagnosis was practice Pattern 4I: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated With Bony or Soft Tissue Surgery according to the *Guide to Physical Therapist Practice*.[27]

The next plan of action was to proceed with intervention following short and long term goals that were developed (Table 2). The interventions were directed to improve functional capacity in order to work and to be able to meet the demands of a football athlete. Emphasis was on core exercise and transverse abdominal (TA) motor control and abdominal bracing. Neuromuscular Re-education was included to increase motor control, increase trunk stability, and muscular re-education. Manual therapy was utilized to increase joint ROM in the spine, scar tissue management, and to provide trigger point release and soft tissue massage for pain. Due to the patient's active lifestyle, intact cognition, motivation to return to football, compliance with physical therapy, no existing comorbidities or complications, and reporting a good home environment and family support system, all these factors were considered to be positive prognostic indicators for an excellent recovery.

Reexamination or discharge plans were to follow 10 visits or 30 days upon which the patient was scheduled for a doctor follow-up and physical therapy progress note with reexamination of previous measurements. The patient would be discharged upon completion of goals and / or demonstration of proper functional status to play football.

Intervention

Coordination, communication, documentation

All elements of documentation including examination, evaluation, diagnosis, prognosis, and intervention were discussed with the patient and made accessible if requested. All documents were recorded in daily charts and saved on electronic file for future reference. Open communication with experienced physical therapists in the clinic was an ongoing process to provide optimum care for the patient.

.Patient / client related instruction

The patient was educated and instructed with a home exercise program including hand-outs for visual feedback. The patient was instructed in postural control and awareness to help improve function and manage symptoms at work. Expected outcomes and prognosis were also discussed to give the patient a clear understanding of the time frame for his program. The patient was highly motivated and compliant with home exercise therapy.

Procedural interventions

A frequency and duration of 2 x / week with 60 minute sessions for 4-6 weeks was established based on his schedule, referral for physical therapy, and expected outcomes. However, due to family emergencies and illness, the patient was unable to attend physical

therapy 2x / week consistently. In the end, the patient was seen for 60 minutes per day for a total of 10 visits. On the 10th visit, the patient requested to be discharged.

Therapeutic Exercise

To prepare the body for exercise and prevent further injury, the recumbent bicycle or elliptical machine was used for 10 minutes during warm-up to increase the patient's heart rate and blood flow to working muscles. The patient was set on level 5 using "quick start" mode and informed to pedal with minimum to moderate intensity. Due to impairments in strength, range of motion, and pain involving the trunk, therapeutic core exercises were considered the most important part of the physical therapy program. Exercises performed were suggestions from experienced physical therapists, clinical experience, and exercises described in Kisner and Colby.[26]

Although there were variations in the number of sets, repetitions, and duration of exercise, (Table 3), the rule for progression was to slowly overload by increasing the amount of repetitions and / or sets before increasing the difficulty of the exercise. Exercises were not performed if it increased his pain. In addition, proper demonstration of technique was required before progressing to new exercises. The initial approach to the program was to first establish proper motor and neuromuscular re-education of core muscles during low level bed exercises known as phase 1. Proper demonstration of these exercises was accomplished by the patient's 2nd visit of the first week. By the 2nd week, the patient was able to progress and tolerate gross body movements and external resistance from elastic bands, medicine balls, and the use of Swiss balls known as phase 2. By the 5th week and 8th visit, the patient was able to demonstrate proper form with minimum verbal feedback for all exercises within phase 1 and 2. During the final 3

visits, football drills were incorporated to simulate actual drills in a football practice known as phase 3.

Regardless of the specific exercise, emphasis was always placed on maintaining a neutral spine (e.g. not hyperextending) and stabilizing the core with abdominal bracing. Due to impairments of range of motion and motor function, a stretching program targeting the hamstring, quadriceps, hip flexor, piriformis, and calf muscles was incorporated in the plan of care (Figure 1). Each stretch was held for 30 seconds and performed two times bilaterally.

Manual therapy

Manual therapy for pain and decrease in range of motion was either done following the warm-up or towards the end of daily treatment for 15 minutes with techniques described by Freddy and Kaltenborn.[18] Passive accessory intervertebral movement (PAIVM) involving posterior anterior mobilization were performed on the lumbar spine using grades I & II for pain, and on the thoracic spine using grades III & IV for hypomobility. Manual therapy began on the 1st visit primarily involving soft tissue and scar tissue massage. At least one technique of manual therapy was provided in each visit depending on patient symptoms.

Outcome

The patient originally had low back pain and stiffness at the start of his program but significantly improved by the end of treatment. By the end of week 4, his reported back pain reduced to minor pain in his low back and tightness in his upper back. By week 5, the patient reported 0/10 pain and demonstrated improved endurance with more difficult activities. All range of motion and flexibility measures of the lower extremity and trunk improved significantly by the conclusion of treatment except iliotibial band tightness which was assessed by a positive

Ober's test. All strength impairments of the hip, abdominals, and lumbar multifidus improved to 5/5 following the program. The patient made great improvements in the Oswestry Low Back Pain Disability Index from 30% disability at the beginning of treatment to 0% disability by the end. By week 5, no abnormalities were found in his gait pattern compared to an antalgic gait and right lateral trunk lean observed during his examination.

The patient's posture only improved momentarily following manual therapy and with verbal cueing. When observing the patient arrive or leave after each session, no changes were observed and he continued to display rounded shoulders, a forward head posture, and decreased lordotic curve. It is important to note, however, that the patient reported satisfaction and decrease in low back pain when sitting upright and correcting his posture during work. The patient made significant improvements in body mechanics following squat training. During his evaluation, he demonstrated poor technique and understanding of body mechanics which resulted in his weight heavily distributed anterior to his base of support, resulting in loss of balance and knee pain. By the end of week 4, he was able to display proper form and technique with no loss of balance or knee pain. He also demonstrated proper squatting with alternating feet and on a Bosu for the remaining visits. By the end of treatment and discharge, all goals were successfully met. In addition, the patient reported satisfaction with his return to normal function and making the football team following try-outs that week.

Discussion

Although there is evidence to support the success rate of NFL players returning to football following discectomy, less is known regarding the interventions that played a role in

their return.[10] This case study describes the interventions and the rationale behind the choices made for a recreational football player following discectomy.

Core stability exercises had been utilized during every treatment session in this case report. Interestingly, when the patient progressed to more difficult exercises that required greater trunk endurance, he tolerated the change well without fatiguing. Similarly, Anoop et al.[12] concluded core stability training leads to significant improvement in the lower trunk endurance performance in the recreationally active adult (18-27 years).

There is evidence to suggest positive effects from a core exercise program on pain and active range of motion in patients with chronic low back pain.[14, 15, 16] In this case, low back pain had been a negative factor since the start of therapy. By week 5, all pain had subsided according to the patient. It is unclear whether manual therapy, core stabilization exercises, stretching, or cardiovascular exercise with the recumbent bike and elliptical was solely responsible for the positive outcome of pain loss. More importantly, the combination of these interventions may have had a greater influence. Future research to determine which of these interventions or combination is most effective would help to clarify the approach and time efficiency for treatment.

All gait abnormalities were no longer observed by week 4. At this point, pain had significantly reduced as reported by the patient. Although decreasing his back pain may suggest a role in gait improvement, it is difficult to determine how much of a role it played in improving his gait compared to other interventions and patient education. No changes were made with the patient's posture during observation in the clinic. It must be mentioned, however, that upper

extremity stretching to help address rounded shoulders was not part of the intervention plan because treatment primarily focused on his low back.

The patient's proper demonstration of a squat occurred during week 4. Although he had been receiving care for hypomobility of the spine and muscle length, it appeared that range of motion may not have been the limiting factor to demonstrate proper technique. Education may have played a greater role as the patient demonstrated immediate improvements in technique following instruction and feedback. Due to a number of factors including compliance and motivation, this patient had an excellent prognosis from the start which may have also contributed to the high success in outcomes. Although there is a high success rate to return to normal function and sports following discectomy, more research is needed on long term satisfaction or complications of patient's following discectomy.

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449 Table 1. Summary of examination procedures.

Measurement	Initial Evaluation	Discharge
	Bilaterally	Bilaterally
Manual Muscle Test		
Hip Flexion	4+/5	5/5
Hip Extension	4+/5	5/5
Hip Abduction	5/5	5/5
Hip Adduction	4+/5	5/5
Knee Flexion	5/5	5/5
Knee Extension	5/5	5/5
Ankle dorsiflexion	5/5	5/5
Toe Extension	5/5	5/5
Eversion	5/5	5/5
Inversion	5/5	5/5
Abdominals (upper)	4/5	5/5
Abdominals (lower)	4/5	5/5
Lumbar multifidus (LM)	4/5	5/5
Range of Motion		
Lumbar Flexion	25% limited	WNL
Lumbar Extension	WNL	WNL
Right Side Bend	25% limited	WNL
Left Side Bend	20% limited	WNL
Hamstring Muscle	Moderately impaired	Minimally impaired
Straight leg raise	+	-
Thomas Test	+	-
Obers Test	+	+
Oswestry Low Back Index	30/100	0/100
Gait	Minimal antalgic gait pattern with a right lateral trunk lean.	Normalized gait pattern, no antalgic gait or lateral trunk lean observed.
Posture	Rounded shoulders, forward head, and decreased lordotic curve.	No changes observed.
Sensation	Intact with crude and light touch.	No changes found.
Joint Integrity / Mobilization of the Spine	Grade 2 grossly.	Grade 3 thoracic and cervical.
Squat Assessment	Poor body mechanics during squat, poor balance, weight shifted anterior to base of support	Proper demonstration of body mechanics during squat. No loss of balance, weight distributed evenly with no knee pain.

	resulting in knee pain.	
Numeric Pain Rating Scale	6/10	0/10

Table 2.

Short and long term goals from initial evaluation to discharge.

Short term goals	Long term goals
• In 2 weeks, patient will be educated with a home exercise program and demonstrate proper biomechanics with minimum cues.	• In 4 weeks, patient will increase strength by ½ grade grossly to improve functional status at work and to play football.
• In 2 weeks, patient will improve his Low Back Index Score by 10 to improve functional status.	• In 4 weeks, patient will improve range of motion grossly from moderately to minimally limited to improve functional status at work and to play football.
• In 2 weeks, patient will report improvement in pain by 2 based on the Numeric Pain Scale.	• Until discharge, patient will demonstrate proper biomechanics during exercise independently to improve function and ability to play football

Table 3. Intervention description of weeks 1 – 6.

Phase	Exercise	Rationale	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
-----	Stationary bike	Warm-up	-----	10 mins	10 mins	10 mins	-----	-----
-----	Elliptical	Warm-up	-----	-----	-----	-----	10 mins	10mins
1) Neuromuscular re-education and motor control during bed exercises	Supine transverse abdominal (TA) contractons and abdominal bracing.	Isolating TA contractions for neuromuscular re-education and motor control. Abdominal bracing to incorporate TA and entire core stabilization.	2 sets x 10 reps	2 sets x 20 reps	Discontinued; added to home exercise program	-----	-----	-----
1	Heel slides	Stabilizing core with lower extremity movement	1 set x 10 reps	2 sets x 10 reps	Discontinued; added to home exercise program	-----	-----	-----
1	Supine TA contractions with marching	Maintaining TA contraction with lower extremity movement	2 sets x 10 reps	2 sets x 20 reps	Discontinued; added to home exercise program	-----	-----	-----
1	Bridges	Improve lower extremity	-----	2 sets x 10 reps	3 sets x 10 reps	3 sets x 20 reps	Discontinued; added to home	-----

		extension strength					exercise program	
2) Gross body movements and use of equpitment	Abdominal crunches	Active flexion stretch of lumbar region and strengthening of core	-----	-----	3 sets x 10 reps (without medicine ball)	3 sets x 20 reps (without medicine ball)	3 sets x 10 reps (5lb medicine ball)	Discontinued; added to home exercise program
2	Abdominal crunch with lateral flexion	Active stretch of lateral trunk and strengthening core	-----	-----	3 sets x 10 reps	3 sets x 10 reps	Discontinued; added to home exercise program	-----
2	Marching and long arc quad exercise on Swiss ball	Abdominal bracing with lower extremity movement on an unstable surface	-----	1 minute each	2 minutes each	2 minutes each	Discontinued due to progression	-----
2	Abdominal roll out with Swiss ball	Stabilization of core against gravity on an unstable surface	-----	2 sets x 10 reps	3 sets x 10 reps	3 sets x 10 reps	Discontinued; added to home exercise program	-----
2	Prone back extension on Swiss ball	Lumbar multifidus and back extension strengtheni	-----	-----	3 sets x 10 reps	3 sets x 10 reps	Discontinued; progressed to alternating with extremities	-----

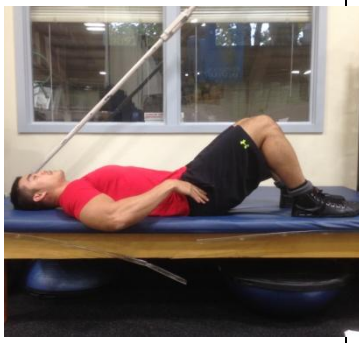
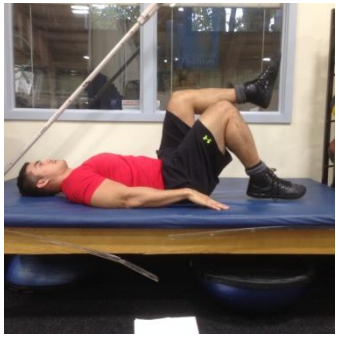
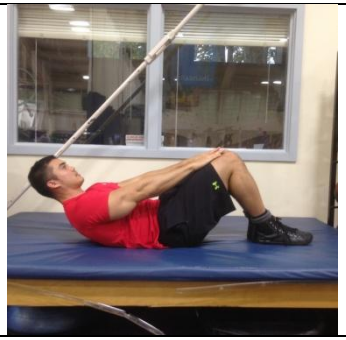
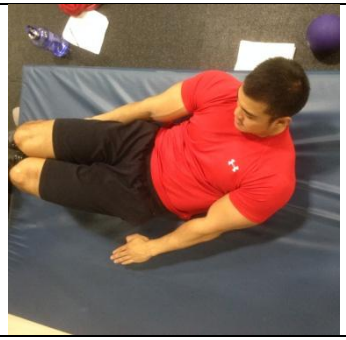
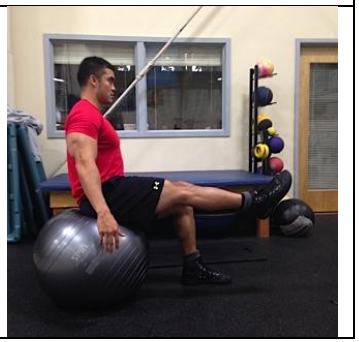
		ng						
2	Prone alternating upper extremity and lower extremity extension	Lumbar multifidus strengthening and core stabilization with upper and lower extremity movement	-----	-----	-----	-----	3 sets x 10 reps	3 sets x 10 reps
2	Abdominal contractions with lower extremity cycling, kicks, and isometrics	Core strength and endurance with sustaining leg movements	-----	-----	-----	-----	30 seconds each	30 seconds each
2	Trunk stabilization with elastic bands	Core stabilization with external force	-----	-----	3 sets x 10 reps bilaterally; green band resistance	3 sets x 15 reps bilaterally; green band resistance	3 sets x 10 reps bilaterally; blue band resistace	Discontinued due to progression
2	Planks	Core stabilization against gravity	-----	-----	-----	2 sets x 30 seconds	3 sets x 30 seconds	3 sets x 30 seconds
2	Arm walk-out on Swiss ball	Core stabilization on unstable	-----	-----	-----	1 set x 5 reps	2 sets x 5 reps	3 sets x 5 reps

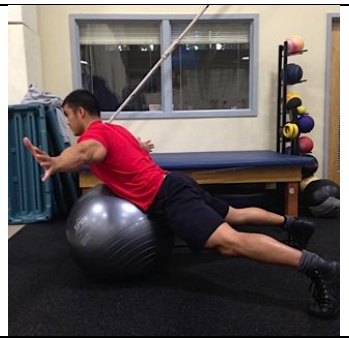
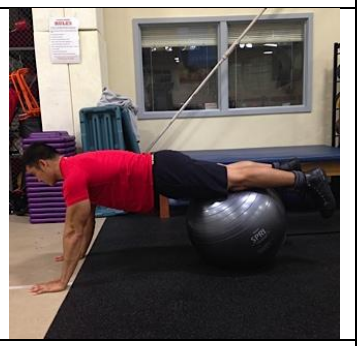
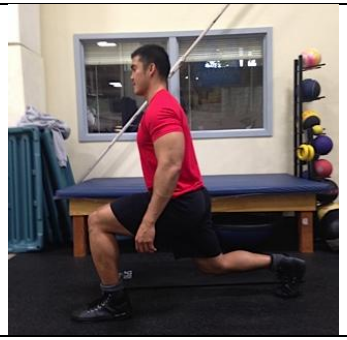
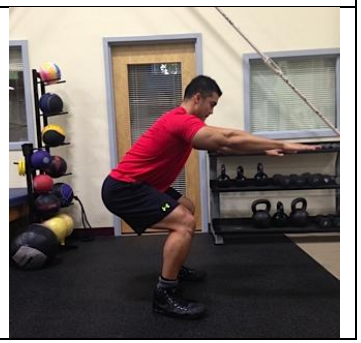
		surface						
2	Lunges	Core stabilization and lower extremity strengthening	-----	-----	-----	-----	1 minute	1 minute
2	Body mechanics (squat training on flat surface)	Education, demonstration, and cueing of proper body mechanics during squat	Education and demonstration only	1 set x 10 reps	2 sets x 10 reps	3 sets x 10 reps	Discontinued due to progression	-----
2	Squats on Bosu ball	Squats with unstable surface for strengthening and motor control	-----	-----	-----	-----	-----	3 sets x 10 reps
2	Squats with alternating feet position	Progression from normal squats on Bosu	-----	-----	-----	-----	3 sets x 10 reps bilaterally	3 sets x 10 reps bilaterally (peformed on Bosu ball)
2	Lower extremity shuttle	Lower extremity strengtheni	-----	-----	-----	-----	5 minutes with 5 bands	5 minutes with 5 bands

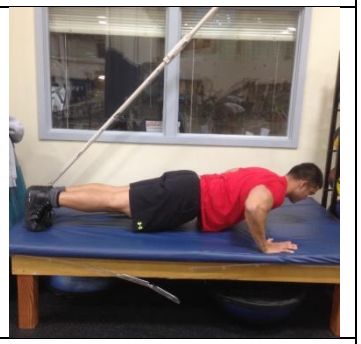
		ng						
2	Push-ups	Core stabilization against gravity with upper extremity movement	-----	-----	-----	-----	1 sets x 10 reps	2 sets x 10 reps
3) Football drills	Back pedal	Simulating functional movement during football	-----	-----	-----	-----	1 minute	1 minute
3	Lateral shuffle	Simulating functional movement during football	-----	-----	-----	-----	1 minute	1 minute
3	Lateral shuffle with ball toss	Simulating functional movement during football	-----	-----	-----	-----	1 minute with 5lb medicine ball toss	1 minute with 5 lb medicine ball toss
3	Lateral shuffle with elastic bands on ankle	Simulating functional movement during football	-----	-----	-----	-----	1 minute; red theraband	1 minute; green theraband
3	Lateral shuffle with rotation	Simulating functional movement during football	-----	-----	-----	-----	1 minute; rotation with 5lb medicine ball	1 minute; rotation with 5 lb medicine ball
Stretching	Hamstring,	Increase	2 sets x 30	2 sets x 30	2 sets x	2 sets x 30	Discontinued	Discontinue

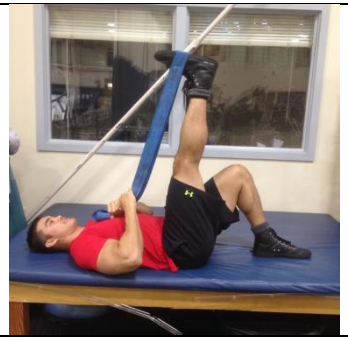
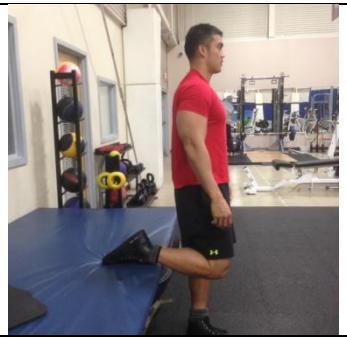
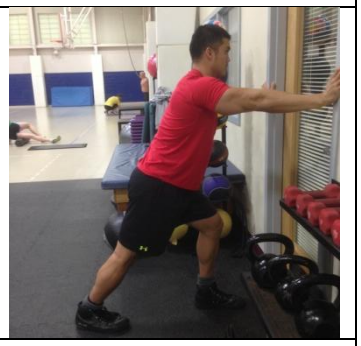
	quadricep, hip flexor, piriformis, or calf muscles	muscle length and range of motion	seconds each	seconds each	seconds each	seconds each	; added to home exercise program	d; added to home exercise program
Manual therapy	Posteroanterior (PA) mobilization of thoracic and lumbar spine	Decrease pain, increase range of motion	15 minutes of PA mobilization grades 1-2	15 minutes of PA mobilization grades 1-2	15 minutes of PA mobilization grades 1-2	15 minutes of PA mobilization grades 1-2	15 minutes of PA mobilization grades 1-2	15 minutes of PA mobilization grades 1-2

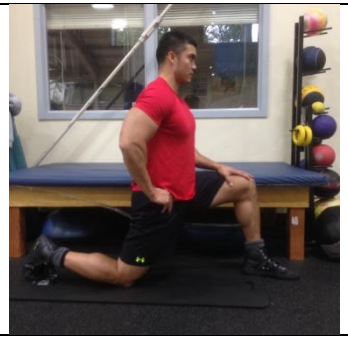
Figure 1. Phase 1. Neuromuscular re-education and motor control during bed exercises, phase 2. Gross body movements and use of equipment, and phase 3. football drills of exercise interventions. Phase 1 is the lowest level of difficulty, while phase 2 and 3 are progressively more difficult.

Phase 1				
Description	**Supine transversus abdominis contractions:** Patient pulls in belly button to contract transversus abdominis; abdominal bracing includes the entire core	**Heel slides:** While maintaing abdominal bracing extend the hip and knee away and slowly return	**Supine transversus abdominis contractions:** Alternate hip position from 45 degrees to 90 degrees of flexion as in “marching” while maintaining transversus abdominis contraction	**Bridges:** Extend hips from hook lying position while maintaing a neutral spine
Phase 2				

Description	**Abdominal crunches:** From supine, slide extended arms towards distal femur to flex trunk and core	**Abdominal crunch with lateral flexion:** Trunk flexion, followed by lateral trunk flexion	**Marching on Swiss ball:** March slowly with core stabilization	**Long arc quads on Swiss ball:** Alternate knee extension slowly with core stabilization
Phase 2				
Description	**Abdominal roll out:** From high kneeling, slowly roll away maintain a neutral spine and core stabilization then slowly return	**Prone back extension:** Slowly extend trunk back including arms for maximum contraction throughout extension	**Prone alternating upper extremity and lower:** Alternate arm and leg simultaneously and extend	**Arm walk-out on Swiss ball:** Prone, starting with ball at mid section, slowly arm walk forward while maintaining core stabilization
Phase 2				

Description	**Trunk stabilization push outs:** Maintain stable trunk and slowly push bands away from body and slowly return. Perform bilaterally.	**Abdominal contractions with lower extremity movement:** Maintain core stabilization while either cycling off edge of bed, slowly kicking, or maintaining knee extension in isometric hold.	**Lunges:** Walking lunges while maintaining stable core	**Body mechanics squat training:** Sit hips back in squat as if sitting on a chair, slowly decending with neutral spine before returning
Phase 2				
Description	**Squat on Bosu:** Perform squat on Bosu while maintaing core stability	**Squat with alternating feet position:** When performing squat, most weight should be bearing on forward leg	**Shuttle:** Slowly extend hips and knees to push slide away from body and slowly return	**Push-ups:** Slowly perform while maintain a stable core without hyperextension of the lumbar spine
Phase 3: Football drills				

	Back pedal: Maintaining neutral spine with core stabilization in squat position, back pedal at maximum speed	**Lateral shuffle:** Maintain neutral spine with core stabilization in squat position. Laterally shuffle at maximum speed. This picture is displaying the drill with a ball toss to add external perturbration. Rotation was added to the exercise as well.	**Lateral shuffle with elastic band:** Maintain neurtral spine with core stabilization in squat position, laterally shuffle against band resistance	
Stretches				
	Hamstring: Hold stretch without pain for 30 seconds and repeat twice	**Piriformis:** Hold stretch without pain for 30 seconds and repeat twice	**Quadriceps:** Hold stretch without pain for 30 seconds and repeat twice	**Calf:** Hold stretch without pain for 30 seconds and repeat twice

Stretches				
	Hip flexor: Hold stretch without pain for 30 seconds and repeat twice			